

An Electromagnetic Actuator for Helicopter Rotor Active Control

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There is considerable interest in the potential of active rotor control as a means of improving rotorcraft loads, vibration, noise, and performance by using various approaches including individual blade control, on-blade controls, and active twist. Smart materials and actuators figure prominently in many of these approaches, but at present this technology is limited with respect to actuation force and displacement capability, as well as maturity level of the underlying technologies.

With these considerations in mind, the U.S. Army Aeroflightdynamics Directorate (AFDD) investigated alternative technologies for individual blade control surface actuation, and solicited proposals under the Small Business Innovative Research (SBIR) program.

The Heliflap™ is an electromagnetic actuator and trailing-edge control surface developed for helicopter rotor active-control applications. It is a rugged, compact system with no external linkages and no moving parts except the flap itself. It has excellent force, deflection, and frequency characteristics, as well as good power and thermal dissipation characteristics. The flap amplitude and frequency are controlled by modulation of the electrical current to the actuators. The net installed weight for the non-optimized prototype is 9.6 pounds. The design and development of the Heliflap has been completed including bench testing and preliminary whirl testing on a full-scale OH-58 helicopter rotor (figure 1) at rotor speeds up to 81% of normal operations and at low collective pitch settings.

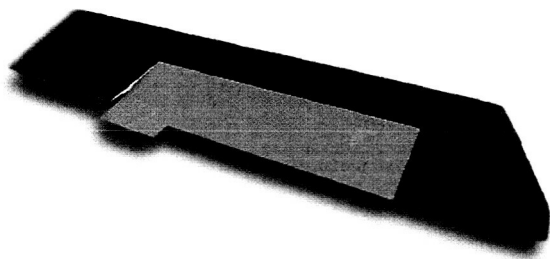


Fig. 1. Prototype Heliflap™ installed in an OH-58 rotor blade.

Test results compare favorably with design predictions from the Heliflap analytical model. Bench testing demonstrated 35.6 foot-pounds static torque for 100 amperes, ± 8 -degree deflections, and operation from 0–37 hertz. Whirl testing of the 6- by 24-inch prototype at 81% nominal rotor speed demonstrated ± 6 -degree deflections at 21 hertz (4.4 times per rotor revolution) requiring a total average electrical power of 220 watts. The actuator appears to be well suited for active control for rotor vibration reduction and may have significant potential for application to rotor primary flight control as well. A comparison of test results with computer predictions of the actuator performance is shown in figure 2.

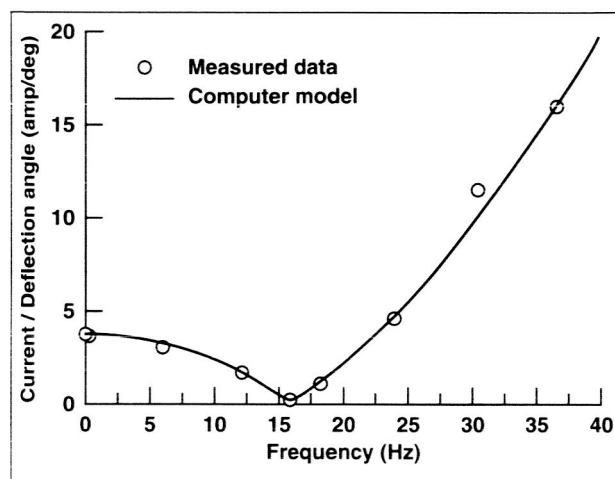


Fig. 2. Current required per degree of deflection versus frequency for a nonrotating blade.

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